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IS 5555 (1970): Code of procedure for conducting field studies on atmospheric corrosion of metals [MTD 7: Light Metals and their Alloys]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

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IS : 5555 - 1970

(Reaffirmed 2002)

Indian Standard

CODE OF PROCEDURE FOR CONDUCTING FIELD STUDIES ON ATMOSPHERIC CORROSION OF METALS

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Indian Standard
**CODE OF PROCEDURE FOR
CONDUCTING FIELD STUDIES ON
ATMOSPHERIC CORROSION OF METALS**

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 November 1970, after the draft finalized by the Corrosion Protection Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This code has been prepared to provide a systematic and uniform procedure for conducting exposure tests of metals and alloys for collection of corrosion and pollution data.

0.3 This code has emerged as a result of detailed investigations instituted by the Corrosion Sites Panel of the Metals Research Committee of Council of Scientific and Industrial Research (CSIR). In the formulation of this code considerable assistance has been derived from the publication 'Instruction manual for conducting field studies on atmospheric corrosion of metals', prepared by B. Sanyal and G. K. Singhanian, and published by the Defence Research Laboratory (Materials), Kanpur.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS: 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This code deals with the procedure of conducting indoor and outdoor exposure tests on metals and alloys for collection of corrosion and pollution data.

1.2 Recommended methods for determination of atmospheric sulphur dioxide; salinity; air pollution, solid materials; temperature; humidity, rainfall and dew have also been described in the Appendices A to E.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this code, the following definitions, in addition to those given in IS : 3531-1966*, shall apply.

2.1 Dew Day — A day on which at least 1 ml of dew is collected overnight on an area of 100 cm².

2.2 Monthly Corrosion Rate — The loss in thickness, calculated on the weight loss per unit area of panel exposed for a period of one month and expressed in mm/dm².

2.3 Panel — A rectangular piece of metal of specified size, used for conducting exposure tests for corrosion studies.

2.4 Rainy Day — A day on which the rainfall exceeds 2.5 mm.

2.5 Yearly Corrosion Rate — The loss in thickness, calculated on the weight loss per unit area of panel exposed for a period of one year of 12 successive months and expressed in mm/dm².

3. EXPOSURE SITE

3.1 For the purpose of selection of exposure site, the country has been divided into eight climatic regions as indicated in Fig. 1 (see P 5).

3.2 The site shall be so selected as to appropriately represent one of these climatic regions.

3.3 In the location of the site care shall be taken against any obstructions to the free passage of air to the site.

4. MATERIAL OF PANELS

4.1 The test panels to be exposed shall be of mild steel and zinc. Other metals like galvanized steel, copper, aluminium, tinplate and stainless steel, may also be exposed if required. All metals used shall conform to appropriate Indian Standards.

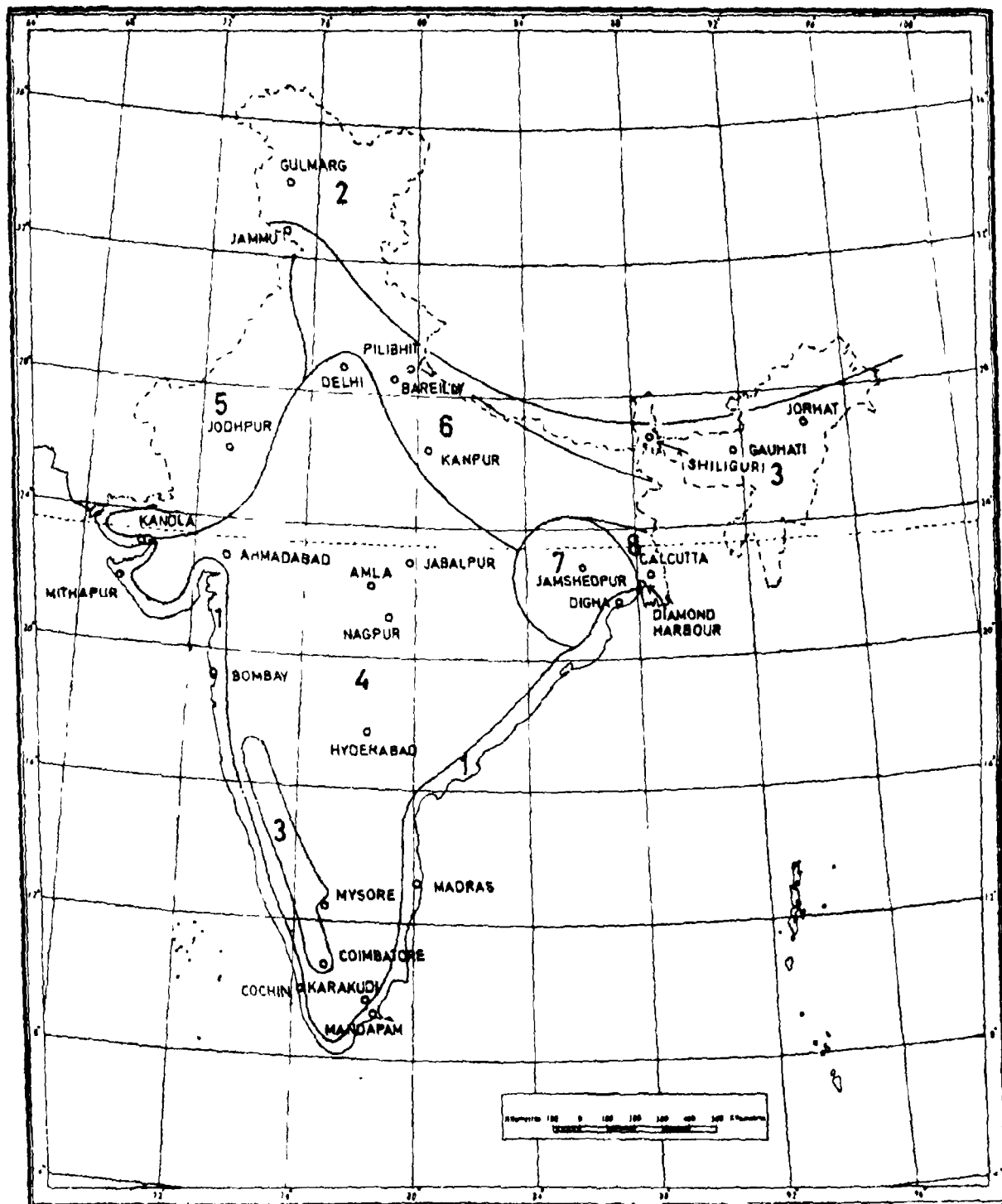
5. SIZE OF PANELS

5.1 The size of panels shall be 150 × 100 mm for outdoor exposure and 150 × 50 mm for indoor exposure. A thickness of 1.25 mm is recommended for mild steel and zinc panels. For other metals and alloys any convenient thickness may be used.

*Glossary of terms relating to corrosion of metals.

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THE CLIMATIC MAP OF INDIA



Based upon Survey of India map with the permission of the Surveyor General of India
The territorial waters of India extend into the sea to a distance of twelve nautical miles
measured from the appropriate base line

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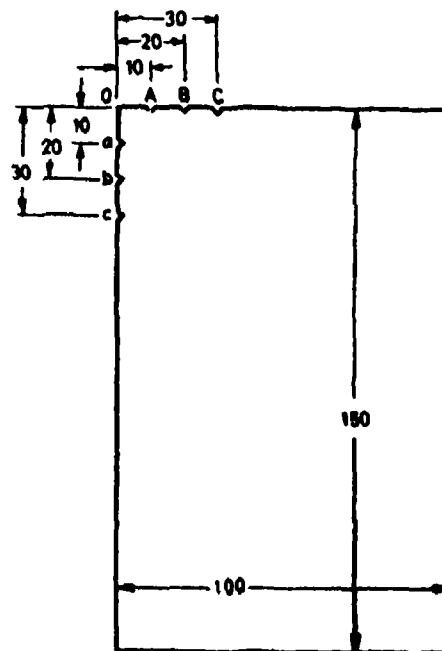
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FIG. 1

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6. IDENTIFICATION AND MARKING OF PANELS

6.1 Identification marks shall not be stamped on the specimens as they are likely to be obliterated by corrosion. Instead, notches (at 1 cm distances) shall be cut at different distances from the corner along the edges of short and long sides of the specimens. With two notches on two sides on each specimen at different distances from a corner, large number of combinations will be available for identification. As an example, Fig. 2 shows the positions of notches for different specimens. Specimens (*Aa*, *Ab*, *Ac*) shall be denoted in records as 1.1, 1.2 and 1.3, respectively and specimens (*Ba*, *Bb*, *Bc*) as 2.1, 2.2 and 2.3, respectively.



All dimensions in millimetres.

FIG. 2 METAL SPECIMEN

7. PREPARATION OF TEST PANELS

7.1 The metal panels shall be cut to size from a single sheet or from sheets manufactured in the same batch. The specimens shall be burnished with emery cloth of IS grit No. 80 on both sides and then finally with emery cloth of IS grit No. 180, first lengthwise and then breadthwise, finishing with circular motions until the whole surface is covered with circular burnishing

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marks. No treatment shall be given to galvanized steel, tinplate and stainless steel. These will be exposed in 'as received' condition after properly degreasing in accordance with 7.2. In case of aluminium, pumice powder or alumina abrasives shall be used instead of emery.

7.2 All metal panels shall then be degreased by swabbing vigorously with cotton soaked in sulphur-free toluene, benzene or acetone. The panels shall be finally cleaned by rinsing in methanol to remove sweat and finger prints. The panels shall be dried in a stream of dry air (a hair drier is suitable for this purpose). During and after degreasing, the panels shall not be handled with bare hands but with a pair of clean forceps.

8. EXPOSURE OF PANELS

8.1 The panels shall be exposed both under outdoor as well as indoor conditions. All panels shall be weighed before exposure.

8.1.1 Meteorological observations, like determination of atmospheric sulphur dioxide; salinity; air pollution; solid materials; temperature; humidity; rainfall and dew; shall be made as described in Appendices A to E.

8.2 Outdoor exposures shall be carried out on suitable wooden, aluminium or monel racks as shown in Fig. 3 (*see* P 29). The recommended method of grouting the frame to the ground is shown in Fig. 4 (*see* P 30).

8.2.1 The panels shall be held at an angle of 45° to the horizontal. Subject to the facilities available, exposure tests may also be carried out at 90° angle (vertical). Specimens shall face south and shall be exposed at 1 to 1.5 metres above the ground level. The panels shall be held in position by ceramic or perspex cleats.

8.2.2 The panels shall be so arranged and fixed to the frame that corrosion products or leachings from one panel do not contaminate the other and minimum area of the panels is shielded during exposure. Any bimetallic contact with bolts, nuts or frames shall be avoided.

8.3 Indoor exposures shall be carried out in Stevenson's screen. Figure 5 (*see* P 31) and Figure 4 show details of the screen and method of grouting it in the ground respectively.

8.3.1 The screen shall be so placed that one of its longer sides shall face south. The panels shall be equally spaced inside the screen and be held at an angle of 90° to the horizontal.

9. DURATION OF EXPOSURE

9.1 The following data shall be collected:

- a) Monthly corrosion rate, and
- b) Yearly corrosion rate.

9.1.1 For monthly corrosion rate, two fresh panels of the metal under test shall be exposed every month. That is, if a test is initiated on a certain date, the panels shall be removed from the exposure rack on the same date of the following month.

9.1.2 For yearly corrosion rate, two fresh panels of the metal under test shall be exposed in each successive month of the year and shall be withdrawn after completion of one year's exposure.

10. INSPECTION DURING EXPOSURE

10.1 The exposed panels shall be periodically examined for nature and extent of corrosion.

10.2 One of the two panels in each set exposed for one year shall be weighed every month and the monthly weight increments shall be recorded. These panels shall be put back for continued exposure for a total period of one year. Pitting and perforation of specimens shall be noted.

10.3 For uniformity of record, a recommended method is shown in Pro forma A of Appendix F. This shall be filled every month during exposure.

11. ASSESSMENT OF CORROSION ON CONCLUSION OF EXPOSURE

11.1 For monthly corrosion rates, the panels shall be removed from the exposure rack and the Stevenson's screen and shall be weighed, and the weight increments recorded.

11.1.1 The corrosion products on the panels shall be removed as mentioned in 12 and the losses in weight of panels shall be determined by subtracting the weights of the panels after derusting from the initial weights of the panels.

11.2 For yearly corrosion rates, one of the panels in each set shall be weighed (*see 10.2*) every month and both panels at the end of one year to record the weight increments. They shall then be derusted by appropriate solutions mentioned in Table 1 and the losses in weight shall be recorded.

12. REMOVAL OF CORROSION PRODUCTS

12.1 The exposed panels shall be treated chemically by appropriate method as indicated in Table 1 for removal of corrosion products. The panels shall then be thoroughly washed with distilled water and dried with hot air.

TABLE 1 METHODS FOR CHEMICAL CLEANING OF CORRODED TEST SPECIMENS
(Class 11.2 and 12.1)

MATERIAL (1)	CHEMICAL (2)	TIME (3)	TEMPERATURE (4)	REMARKS (5)
Aluminium and aluminium alloys	Conc. HNO_3 2% CrO_3 , 5% H_3PO_4 solution	2 to 3 minutes 10 minutes	Room 80° to 85°C	Follow by light scrubbing Used when oxide film resists HNO_3 treatment. Follow by conc. HNO_3 treatment, if necessary
Copper and copper alloys	15 to 20% HCl 5 to 10% H_2SO_4 1% acetic acid 5% ammonium acetate	2 to 3 minutes 2 to 3 minutes 10 minutes 5 minutes	Room Room Boiling Hot	Follow by light scrubbing Follow by light scrubbing Follow by light scrubbing. Removes PbO
Lead and lead alloys				Follow by light scrubbing. Removes FeO and/or PbSO_4 Follow by light scrubbing
Iron and steel	80 g/l NaOH 50 g/l mannitol, 0.62 g/l hydrazine sulphate 20% NaOH , 200 g/l zinc dust Conc. HCl , 20 g/l Sb_2O_3 + 1 g SnCl_4 15% CrO_3 , 1% AgCrO_4 soln.	30 minutes, or until clean 5 minutes Until clean 15 minutes	Boiling Cold Boiling Boiling	— — — —
Magnesium and magnesium alloy	15 to 20% HCl 10% H_2SO_4 10% HNO_3	Until clean Until clean Until clean	Room Room 140° F	— — Avoid contamination with chlorides
Nickel and nickel alloys				Follow by scrubbing —
Stainless steel				Follow by light scrubbing —
Tin and tin alloys	15% Na_3PO_4 Saturated solution of ammonium acetate 10% NH_4Cl Followed by 5% CrO_3 , 1% AgNO_3 soln. Saturated ammonium acetate 100 g/l NaCN 10% chromic acid solution	10 minutes 3 to 5 minutes 5 minutes 20 seconds Until clean 15 minutes 3 to 5 minutes	Boiling Room Room Boiling Room Room Room	Follow by light scrubbing — Follow by light scrubbing — — — —
Zinc				—

APPENDIX A

(*Clauses 1.2 and 8.1.1*)

DETERMINATION OF ATMOSPHERIC SULPHUR DIOXIDE

A-0. GENERAL

A-0.1 Sulphur dioxide content of atmosphere shall be determined at each site every month for one year.

A-0.2 Quality of Reagents — Unless otherwise specified, pure chemicals and distilled water (*see* IS : 1070-1960*) shall be employed in the tests.

NOTE — ' Pure chemicals ' shall mean chemicals that do not contain impurities which affect the results of analysis.

A-1. MEASUREMENT OF SULPHUR DIOXIDE BY THE LEAD PEROXIDE METHOD

A-1.1 Equipment and Materials — The equipment required for the estimation is a louvered box. Full details of the equipment are given in Fig. 6 (*see* P 32). Method of grouting the equipment to the ground is shown in Fig. 4. The other materials required for the estimation are glass tubing of 10 cm circumference, surgical gauze of 1 mm mesh, quality lead peroxide, gum arabic and gum tragacanth.

A-1.2 Procedure

A-1.2.1 Estimation of sulphur dioxide by the lead peroxide method shall be carried out in the open air at ground level for a period of one year.

A-1.2.2 The wooden post of the louvered box shall be buried vertically in the ground so that top is about 1.5 m above the ground. The equipment may also be exposed on a roof. In such cases the post shall be at least 0.46 m high. Figure 6 shows the details of the posts used in two types of exposures. At the top of each post a headless nail shall be fixed over which the glass tubing shall be placed. The louvered box shall be fitted to the projection at the post and padlocked in position with the glass tubing inside.

A-1.2.3 Two or three days before the beginning of each month two lead-peroxide coated ' candles ' shall be prepared, out of which one lead peroxide ' candle ' will serve as control.

*Specification for water, distilled quality (*revised*). (Since revised).

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A-1.3 Lead Peroxide Paste

A-1.3.1 A paste of lead peroxide shall be made by mixing 8 g of lead peroxide and about 5 ml gum solution (1 percent solution containing 0.5 percent gum arabic and 0.5 percent gum tragacanth dissolved in 5 percent absolute alcohol/water mixture) with a spatula to produce a paste of suitable consistency. This quantity is sufficient for one candle. When a number of candles are to be prepared it will be convenient to make the paste for four determinations at a time on a ground-glass plate with a spatula and divide it equally.

A-1.4 Preparation of Lead Peroxide 'Candles'

A-1.4.1 A 10 cm square of the cotton gauze shall be tied or sewn round the glass or porcelain tubing (candle), the prepared paste shall be applied evenly to cover the gauze and finally worked smooth with the pad of the little finger. The prepared 'candles' shall be dried slowly in a desiccator or a bell-jar containing quicklime and shall be stored there until required.

A-1.4.2 On the first day of each month, one lead peroxide 'candle' shall be transferred from the desiccator and exposed inside the louvered box. On the first day of the next month the lead peroxide 'candle' shall be replaced by another freshly prepared 'candle' and the former removed to the laboratory for analysis. To make sure that none of the materials has been contaminated by sulphur dioxide and that a negligible amount of sulphur dioxide has been collected during handling, a control 'candle' treated in exactly the same way as the other shall be stored in a desiccator, or in a sulphur-free airtight container for one month.

A-1.5 Analysis

A-1.5.1 The surface area of each 'candle' shall be measured and the period of its exposure shall be noted. The coated gauze shall be stripped off and treated with 5 g of sodium carbonate in about 100 ml of distilled water. After standing with occasional stirring for at least 3 hours, the whole shall be boiled for half an hour the volume being kept nearly constant. The solution shall be filtered through appropriate filter paper and finally the filtrate shall be acidified with hydrochloric acid and sulphate precipitated with barium chloride. The precipitate shall be filtered off, washed, ignited and weighed.

A-1.5.2 The weight of barium sulphate from the control 'candle' should not exceed 2 mg and is usually as low as 1 mg. This weight shall be subtracted from the weight of barium sulphate from each exposed candle.

A-1.5.3 The result of each analysis shall be reported as mg of SO_2 per $100 \text{ cm}^2/\text{day}$ and recorded in Pro forma B given in Appendix F.

APPENDIX B*(Clauses 1.2 and 8.1.1)***MEASUREMENT OF ATMOSPHERIC SALINITY****B-0. GENERAL**

B-0.1 Salinity shall be determined in a pent roof shed by the wet ' candle ' method every month for one year. The shed shall be of such construction as to allow free passage of air inside the shed but no wetting of ' candle ' due to rain.

B-1. EQUIPMENT

B-1.1 The apparatus is illustrated in Fig. 7 (*see P 33*). It consists of the following parts:

- a) A wide mouth glass bottle of one litre capacity with a bakelite lid which serves as a water reservoir.
- b) A glass boiling tube of about 25 mm internal diameter with a side hole at a height of 37 mm from the open end. The inverted glass tube is passed through a hole in the cork fitted to the bakelite lid of the reservoir.

B-2. METHOD OF PREPARATION OF THE ' WET CANDLE '

B-2.1 A roll of surgical gauze 37 mm wide shall be cut into two pieces ' 1 ' and ' 2 ', each of 105 cm length. These shall be boiled in distilled water to remove starch and other impurities. The test-tube shall be held with its open end down. One end of the gauze ' 1 ' shall be pushed through the hole to a length of 9 cm. The remaining length of the gauze shall be wound (clockwise or anticlockwise) in an upward direction starting from the upper edge of the side hole in the test-tube. After winding the gauze to a height of 10 cm the winding shall be made in the downward direction until the upper edge of the side hole is reached. The remaining length of gauze (approximately 9 cm) shall be pushed through the side hole of the test-tube. The other piece ' 2 ' shall be wrapped round the test-tube similarly.

B-3. EXPOSURE OF CANDLE

B-3.1 The diameter of the tube with wrapped gauze shall be measured at three or four places and the mean value D shall be determined. The length L of the gauze shall be determined by taking mean length of the

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tube with wrapped gauze at three or four places. The total area of the gauze surface shall be calculated with the help of formula πDL .

B-3.2 The gauze shall be soaked in distilled water and the reservoir shall be filled to half its capacity with distilled water. The bakelite lid shall be screwed on the bottle. It shall be ensured that the four ends of gauze strips remain dipped in the water.

B-3.3 The apparatus (bottle containing gauze) shall be exposed in a pent roof shed (see Fig. 8, P 34) for a period of one month. Care shall be taken that the gauze always remains moist and as such shall be examined at least twice a week and the water shall be replenished, if necessary. At the end of exposure period the portion of gauze inside the bottle will be cut with a pair of scissors to avoid losses due to dripping. The lid shall be removed and the remaining gauze on the test-tube shall be cut open by means of a sharp blade and shall be transferred to a beaker by means of a glass rod. The contents (gauze and water) of the bottle shall be transferred into the same beaker. Sodium chloride content of the water in the reservoir shall be determined by volumetric analysis and the salinity calculated as in **B-4**.

B-4. DETERMINATION OF SODIUM CHLORIDE CONTENT

B-4.1 The gauze in the beaker shall be boiled in distilled water and the water shall be transferred to a 1 000 ml measuring flask and made up to the mark. An aliquot volume from the measuring flask shall be taken and titrated with standard N/10 silver nitrate using potassium chromate as indicator. The result shall be calculated as follows:

$$\text{Salinity} = \frac{T \times V \times N \times 58.45}{V_1 \times A \times H} \text{ mg of NaCl per m}^2 \text{ per day}$$

where

T = volume in ml of standard silver nitrate solution required for titration,

V = volume in ml of solution from which aliquot has been drawn,

N = strength in terms of normality of standard silver nitrate solution,

V_1 = volume in ml of aliquot,

A = area in m^2 of the exposed gauze, and

H = number of days for which the ' candle ' was exposed.

NOTE — The test shall be conducted with chloride free distilled water. Appropriate correction shall be made in the calculation if chloride is present in the distilled water.

B-4.2 The value shall be reported as mg of NaCl/ m^2 /day and recorded in Pro forma B as shown in Appendix F.

APPENDIX C

(*Clauses 1.2 and 8.1.1*)

MEASUREMENT OF AIR POLLUTION — SOLID MATERIALS

C-0. GENERAL

C-0.1 Dust particles, grit and other atmospheric solid impurities shall be measured with the help of a deposit gauge every month for one year.

C-1. APPARATUS

C-1.1 The complete deposit gauge shall comprise of the following:

- a) Stand;
- b) Collecting bowl;
- c) Collecting bottles, three;
- d) Inverted funnel;
- e) Brush and plug; and
- f) Rubber squeegee and flexible tubing.

C-1.2 Stand — The stand shall be made of mild steel to the dimensions shown in Fig. 9 (*see P 35 & 36*), and shall be galvanized after the components have been joined together. The bird-guard shall be of about 25 mm mesh and shall be attached to the body of the stand. It shall be constructed of a corrosion resistant material, for example, plastics or galvanized iron.

C-1.3 Collecting Bowl — The collecting bowl shall be made of chemically resistant glass or of a suitable plastics material not prone to the accumulation of electrostatic charge and shall be of the dimensions shown in Fig. 9.

C-1.4 Collecting Bottles — The bottles shall be made of a suitable plastics material, such as polythene, preferably with shoulders sloping at 45°, and shall be of the following dimensions:

<i>Dimension</i>	<i>Requirement</i>
Height	45 cm maximum
Diameter of neck:	
External	8.9 cm <i>Max</i>
Internal	3.8 to 7.6 cm
Capacity	10 to 20 litres

C-1.5 Inverted Funnel — Inverted funnel shall be made of polythene to the dimensions shown in Fig. 9A.

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C-1.6 Flexible Tubing — Tubing connecting the collecting bowl and the inverted funnel shall preferably be of a suitable plastics material or of good quality rubber, and of such bore that it will effectively grip the outlet nozzle of the bowl and the inverted funnel.

C-1.7 Brush and Plug and Squeegee — A test-tube or short burette brush with a rubber bung fixed on the handle is suitable. The squeegee may be made by fixing a strip of hard rubber in a suitable holder.

C-1.8 The apparatus shall be assembled as shown in Fig. 9.

C-2. OPERATION

C-2.1 The gauge shall be placed in a suitable open place; care shall be taken that the rim of the collecting bowl is horizontal.

C-2.2 A fungicide consisting of 10 ml of 0.02 N copper sulphate solution (2.50 g of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ per litre) shall be placed in the clean collecting bottle. This is necessary to prevent the growth of algae which would alter the chemical nature of the collected deposit.

C-2.3 On completion of one month the collecting bowl shall be inspected and identifiable foreign matter, such as leaves or insects should be removed from the collecting bowl.

C-2.4 The brush shall then be inserted in the outlet of the collecting bowl and passed downwards through the inside of the tubing and inverted funnel until the outlet of the bowl is securely closed by the plug attached to the top of the brush.

C-2.5 About 500 ml of the liquid in the bottle shall be poured into the bowl and any deposited matter adhering to the bowl dislodged with the squeegee.

C-2.6 If the liquid collected in the bottle is insufficient for this cleansing process a measured quantity of distilled water shall be used. This additional water shall not be added unless it is impossible to wash out the bowl with the rain-water collected.

C-2.7 The plug shall then be removed and the contents of the bowl run, without loss, into the bottle. During this operation the inside of the tubing and the inside of the inverted funnel shall be cleaned by means of the brush.

C-3. ANALYSIS OF DEPOSITED MATTER

C-3.1 Analysis shall be carried out of the deposited matter and the following information shall be obtained:

- a) pH value of the liquid, except where distilled water has been added, and

- b) weight of the insoluble matter. This shall be further analysed for ash, portion soluble in CS_2 and combustible matter insoluble in carbon disulphide. The filtrate from these tests shall be analysed for calcium, chloride, sulphate and total water soluble solids.

C-3.2 The data shall be recorded in Pro forma B as shown in Appendix F.

APPENDIX D

(*Clauses 1.2, C-3.1 and 8.1.1*)

METHODS FOR THE ANALYSIS OF DEPOSITED MATTER

D-1. VOLUME OF WATER

D-1.1 The volume of water shall be determined either:

- a) by weighing the bottle (or bottles) on receipt, and again after emptying at the end of the analysis, making allowance for the weight of the undissolved matter present, or
- b) by measuring the volume of the decanted and filtered water.

D-1.2 The accuracy of measurement shall be of the order of 1 in 100.

D-1.3 Allowance shall be made for any distilled water added in accordance with C-2.6. A note shall be made in the report of results when this special procedure has been followed.

D-2. WATER-INSOLUBLE MATTER

D-2.1 Total Water-Insoluble Matter

D-2.1.1 The whole of the deposit collected (*see D-2.1.2*) shall be used to determine the total water-insoluble matter.

D-2.1.2 The insoluble matter shall be filtered off and dried to constant weight. Suitable filtering media are as follows:

- a) A layer of asbestos in a porcelain Gooch crucible; the prepared crucible shall be ignited before use; and
- b) A sintered silica Gooch crucible, porosity 4.

D-2.1.3 If the water is allowed to stand undisturbed for at least three days prior to filtration the water-insoluble matter will have settled at the bottom of the bottle. In this case the clear supernatant liquid shall be decanted or syphoned off without filtration, without any appreciable loss

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of solid matter. A syphon, with an upturned end or with a closed end and a hole blown in the side about 25 mm from the bottom is suitable for withdrawing the clear liquid.

D-2.1.4 After decantation or syphoning, the residue shall be transferred to a beaker of suitable size and the bottle (or bottles) rinsed thoroughly with some of the decanted liquid, removing any adhering particles by means of a stiff feather, a clean test-tube brush or other suitable means. The residue shall be filtered through the filtering medium and the filtrate added to the clear decanted liquid.

D-2.1.5 Finally, all the water-insoluble matter shall be washed from the beaker to the filter, using distilled water. The filtrate shall be discarded.

D-2.1.6 The filter and water-insoluble matter shall be dried at 100°C to constant weight.

D-2.2 Tarry Matter

D-2.2.1 The total water-insoluble matter shall be extracted with freshly distilled carbon disulphide in a suitable apparatus. The extraction shall be continued to completion as shown by the colour of the carbon disulphide. The time for extraction will vary with the type and amount of water-insoluble matter, but normally about 10 minutes is sufficient.

D-2.2.2 After extraction crucible or filter paper shall be dried and weighed. The loss in weight shall be recorded as ' tarry matter '. Confirmation of the figure can be obtained by evaporation of carbon disulphide used for extraction and weighing the residual tarry matter.

D-2.3 Microscopic Examination

D-2.3.1 If desired, a representative sample of known weight of the extracted water-insoluble matter shall be subjected to microscopic examination.

D-2.4 Ash

D-2.4.1 The extracted water-insoluble matter shall be ignited at $775 \pm 25^{\circ}\text{C}$ to constant weight in an atmosphere free from sulphur, for example, in an electrically heated muffle.

D-2.4.2 If a Gooch crucible has been used, the difference between the final and initial weights is the weight of ash. If filter paper has been used, allowance should be made for the weight of ash of the filter paper.

D-2.5 Combustible Matter Insoluble in Carbon Disulphide

D-2.5.1 The difference between the total water-insoluble matter and the sum of the tarry matter and ash is the combustible matter insoluble in carbon disulphide.

D-3. WATER-SOLUBLE MATTER

D-3.1 pH Value — Ten millilitres of the clear liquid shall be taken in a clean test-tube and 0.2 ml of Universal Indicator added. The colour produced shall be compared with standard charts or by means of a comparator. Alternatively, the pH value may be determined by an electrometric method.

D-3.2 Total Dissolved Matter

D-3.2.1 A known volume of clear liquid shall be evaporated to dryness on a water-bath in a weighed or counterpoised platinum, silica or glazed porcelain dish. This shall be dried to constant weight at 100°C.

D-3.2.2 The actual volume taken will depend upon the total volume available for analysis and the anticipated amount of dissolved matter present.

D-3.3 Calcium

D-3.3.1 A suitable volume of the clear liquid shall be acidified with hydrochloric acid and evaporated to a small bulk. This shall be heated to boiling and, whilst stirring a hot saturated solution of ammonium oxalate [about 42 g of $(\text{NH}_4)_2\text{C}_2\text{O}_4 \cdot \text{H}_2\text{O}$ per litre] shall be added, drop by drop until there is an excess. The solution shall be made just alkaline with 0.880 ammonia and shall be allowed to boil for 5 to 10 minutes. Afterwards the solution shall be allowed to stand for a minimum period of 4 hours, or until the precipitate has settled completely.

D-3.3.2 The liquid shall be filtered through a fine filter paper or preferably through asbestos in a Gooch crucible. The precipitate shall be transferred to the filter, washed with dilute ammonium oxalate solution [1 volume of saturated solution (42 grams per litre) diluted to 1 000 volumes] and then five times with 5-ml portions of water.

D-3.3.3 The precipitate shall be transferred into a beaker, using 100 ml of dilute (10 percent) sulphuric acid. If asbestos has been used as the filtering medium the whole contents of the crucible shall be transferred to the beaker; if filter paper has been used, a small hole in the apex of the cone shall be made and the precipitate rinsed into the beaker with the sulphuric acid solution.

The solution shall be warmed to about 70°C and titrated with 0.1 N potassium permanganate solution. If filter paper has been used, it shall be dropped into the solution.

1 ml 0.1 N $\text{KMnO}_4 \equiv 0.00200 \text{ g Ca}$

D-3.4 Chloride — A suitable volume of the clear liquid shall be evaporated to about 50 ml in a 250-ml conical flask. A measured excess of 0.02 N silver nitrate solution shall be added to the hot, but not boiling, liquid. This shall be allowed to cool, covered with a watch-glass, in a dark place free from chlorine. To the cold solution it shall be

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added 2 ml of an iron alum indicator solution, prepared by adding sufficient cold concentrated nitric acid to a cold saturated solution of ferric ammonium alum to remove the brown colour. The indicator shall not be deeper in colour than pale straw. The mixture shall be titrated with 0.02 N potassium or ammonium thiocyanate solution.

1 ml 0.02 N AgNO_3 used \equiv 0.000 709 g of chloride

D-3.5 Sulphate — A suitable volume of the clear liquid shall be acidified with hydrochloric acid after the addition of a sulphur-free oxidizing agent, for example perhydrol. If required, this shall be concentrated to a convenient bulk, about 250 ml. The solution shall be neutralized with 0.880 ammonia and 2 ml of concentrated hydrochloric acid added. The sulphur shall be precipitated using barium chloride solution, filtered and weighed as barium sulphate.

1 g barium sulphate \equiv 0.412 0 g of sulphate

D-3.6 Presence of 'Foreign Matter' — If the bottle is found to contain foreign matter, for example, insects or pollution from birds, or to have been tampered with, an analysis shall be conducted if possible, at the discretion of the analyst, and a note explaining the circumstances added to the report.

APPENDIX E

(Clauses 1.2 and 8.1.1)

MEASUREMENT OF TEMPERATURE, HUMIDITY, RAINFALL AND DEW

E-1. TEMPERATURE AND HUMIDITY

E-1.1 Measurement of maximum and minimum temperatures and humidity shall be done by means of a thermohygrograph daily for a period of one year.

E-2. RAINFALL

E-2.1 Amount of rainfall shall be measured with the help of a rain gauge and the number of rainy days recorded.

E-3. DEW

E-3.1 Dew shall be collected on a glass funnel of known maximum diameter. The funnel shall pass through a cork fitted to a cylinder or a bottle. The whole assembly shall be kept in an open yard in the evening and shall be removed in the morning so that no evaporation of dew takes place. The number of dew days shall be recorded.

E-4. RECORDING

E-4.1 The data shall be reported in Pro forma A as shown in Appendix F.

APPENDIX F (*Clauses 10.3, A-1.5.3, B-4.2, C-3.2 and E-4.1*)

PRO FORMA A

Meteorological Observations

Station.....Month.....19.....

Latitude.....Longitude.....Height above mean sea level.....

DATE	TEMPERATURE, °C		RELATIVE HUMIDITY (percent)		WIND				PREVALENT WIND DIRECTION DURING THE DAY	RAIN-FALL (mm)	DEW (ml/100 cm ²)
	Max	Min	Max	Min	0830 h		1730 h				
					Direction	Speed km/h	Direction	Speed km/h			
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
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21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											

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- | | |
|------------------------------|-------------------------------|
| 1) <i>Temperature</i> | III) Average of mean humidity |
| I) Average maximum temp. | |
| II) Average minimum temp. | |
| III) Average of mean temp. | |
| 2) <i>Humidity</i> | 3) <i>Rainfall</i> |
| I) Average maximum humidity | Total rain..... |
| II) Average minimum humidity | No. of rainy days..... |
| | 4) Dew |
| | Total dew... .. |
| | 5) Average wind velocity |
| | (km/h)..... |

Form for Reporting Atmospheric Corrosion and Pollution Data

Exposure Station Month..... Year.....

- 1) Metal and size of panel
- 2) Identification mark on panel
- 3) Conditions of exposure (indoor*/outdoor; monthly/yearly, vertical/at 45°)
- 4) Date of exposure of fresh panel (x)
- 5) Date of re-weighing of panel after exposure (y)
- 6) No. of days of exposure ($y - x$)
- 7) Weight in g of freshly prepared panel (initial weight) (a)
- 8) Weight in g of panel after exposure (b)
- 9) Weight increment† in g ($b - a$)
- 10) Change in appearance of the panel during the month under report‡
- 11) Weight in g after derusting (c)
- 12) Loss in g of metal on derusting of unruined and unexposed panel (d)
- 13) Actual loss in g of metal [$a - (c + d)$]
- 14) Sulphur dioxide content of the atmosphere (mg SO₂/100 cm²/month)
- 15) Salinity content (mg of NaCl/m²/month)

*If indoor, clarify whether in Stevenson screen or in What improvised arrangement.

†If ' a ' happens to be higher than ' b ', show a negative figure.

‡Here record the change in colour, and nature of the corrosion products spots, patches, etc, their location and percentage of area affected as compared to the previous month.

PRO FORMA B

**Form for Reporting Test Specimen and Site Details for
Atmospheric Corrosion and Pollution Data**

1) *Metal:*

Composition

2) *Test Specimen:*

- a) Shape
- b) Size (mm)
- c) Thickness (mm)

3) *Preparation of Specimens:*

- a) Removal of mill scale by acid treatment:
 - i) HCl
 - ii) H_2SO_4
 - iii) OtherState concentration and temperature of acid and period of treatment
- b) Surface finish. (Mention grade of emery used)
- c) Method of degreasing and cleaning of specimen.
By solvents. (Give details)

4) *Exposure Site:*

- a) Name of station
- b) Nature of exposure site (marine, industrial, rural, etc)
- c) Description of site:
 - i) Distance and height of neighbouring buildings from exposure site
 - ii) Proximity of site to source of pollution (industrial or marine). (Preferably include a sketch showing location of exposure site and the environments)

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5) *Corrosion Data (Type of Exposure)*

I) Average monthly corrosion rate (30 days exposure)

MONTH AND YEAR	CORROSION RATE (LOSS OF METAL)			
	Angle of Exposure			
	45°		90°	
	mg/dm ²	mm/dm ²	mg/dm ²	mm/dm ²
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

II) Average yearly corrosion rate (1 year's exposure)

PERIOD OF EXPOSURE AND YEAR	CORROSION RATE (LOSS OF METAL)			
	Angle of Exposure			
	45°		90°	
	mg/dm ²	mm/dm ²	mg/dm ²	mm/dm ²
January-December				
February-January				
March-February				
April-March				
May-April				
June-May				
July-June				
August-July				
September-August				
October-September				
November-October				
December-November				

6) *Any Other Relevant Information (for Example, Method of Derusting)*

7) *Atmospheric Pollution (Sulphur Dioxide Content of Atmosphere)*

MONTH AND YEAR	SULPHUR DIOXIDE CONTENT (mg of SO ₂ /100 cm ² /month)	
	At Ground Level	Above Ground Level (Show Height)
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

8) *Atmospheric Salinity*

MONTH AND YEAR	ATMOSPHERIC SALINITY (mg of NaCl/m ² /month)		
	Distance from Sea (Metre)		
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			
December			

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9) *Analysis of Atmospheric Impurities in Deposit Gauge*

MONTH AND YEAR	WATER		TOTAL WATER INSOLUBLE MATTER (g)			TOTAL WATER SOLUBLE MATTER (g)		
	Water (mm) (Rain)	pH Value	Tarry Matter Soluble in CS ₂	Ash	Other Combustible Matter Insoluble in CS ₂	Ca	Cl	SO ₄

January
February
March
April
May
June
July
August
September
October
November
December

10) *Dew*

MONTH AND YEAR	NO. OF DEW DAYS*	TOTAL AMOUNT OF DEW (ml/100 cm ² of collecting surface/month)
----------------	------------------	--

January
February
March
April
May
June
July
August
September
October
November
December

*No. of days when more than 1 ml dew is collected on 100 cm² surface.

11) *Rainfall*

MONTH AND YEAR	NO. OF RAINY DAYS	RAINFALL (mm)
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

12) *Relative Humidity*

MONTH AND YEAR	PERCENT RELATIVE HUMIDITY	
	DAILY AVERAGE, Max	DAILY AVERAGE, Min
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

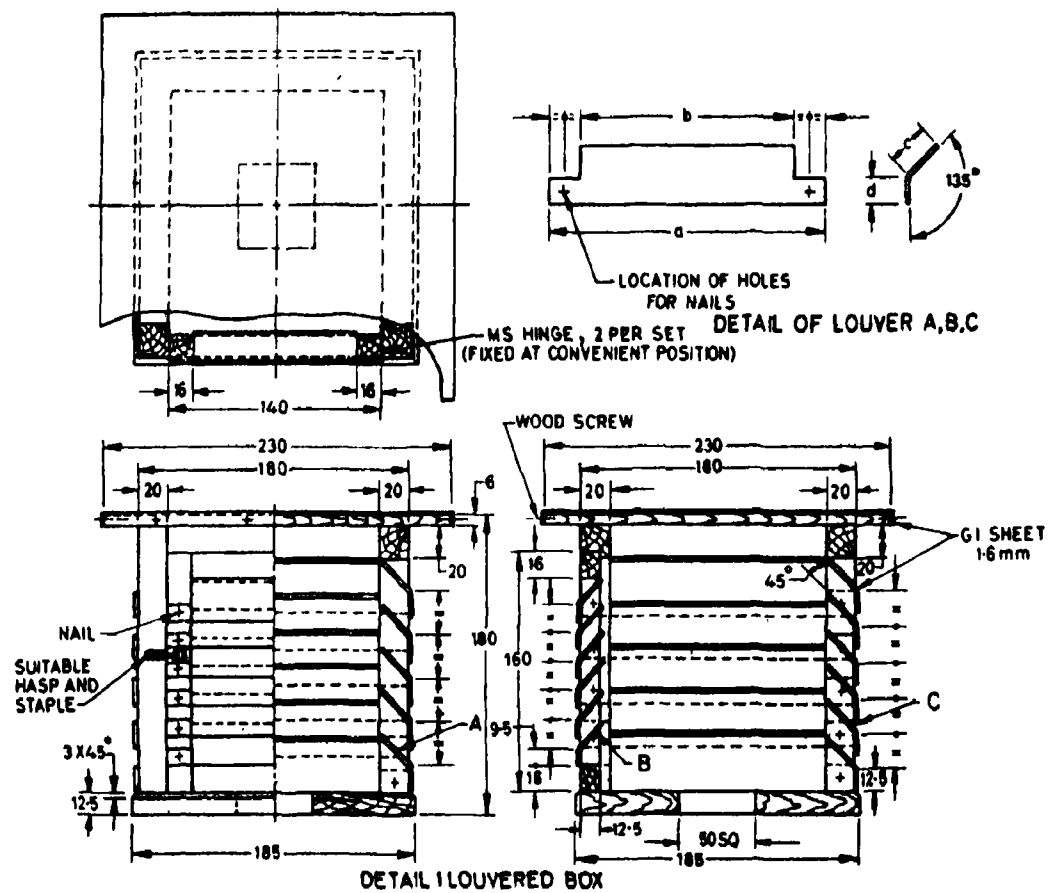
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13) *Temperature*

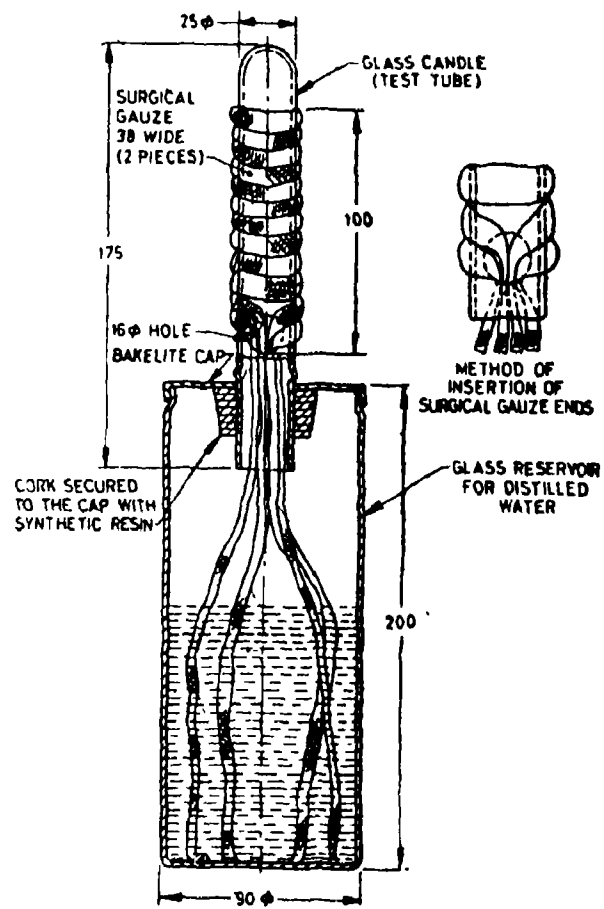
MONTH AND YEAR	TEMPERATURE (°C)	
	DAILY AVERAGE, <i>Max</i>	DAILY AVERAGE, <i>Min</i>
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

14) *Wind Velocity*

MONTH AND YEAR	WIND VELOCITY (Average of Daily Mean) km/h	PREDOMINANT WIND DIRECTION
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		



All dimensions in millimetres.
FIG. 6 LOUVERED BOX



All dimensions in millimetres.

FIG. 7 SALINITY APPARATUS (WET CANDLE METHOD)

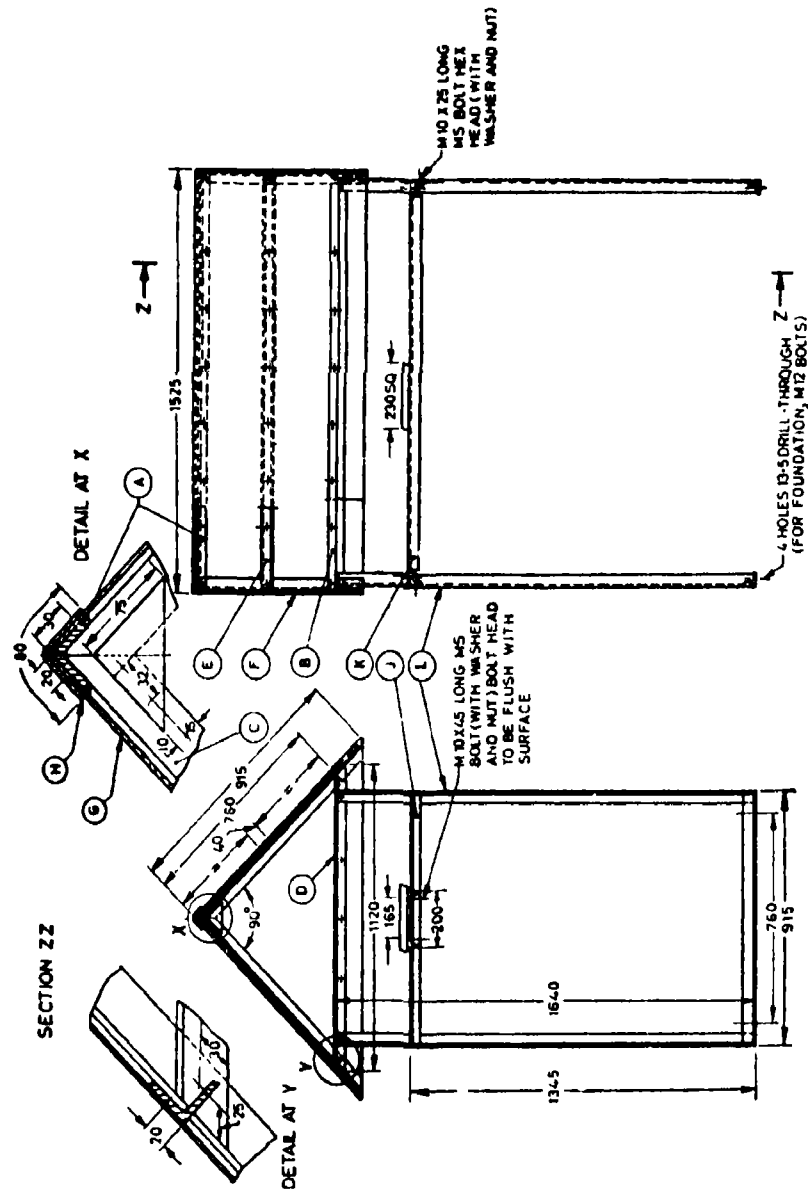
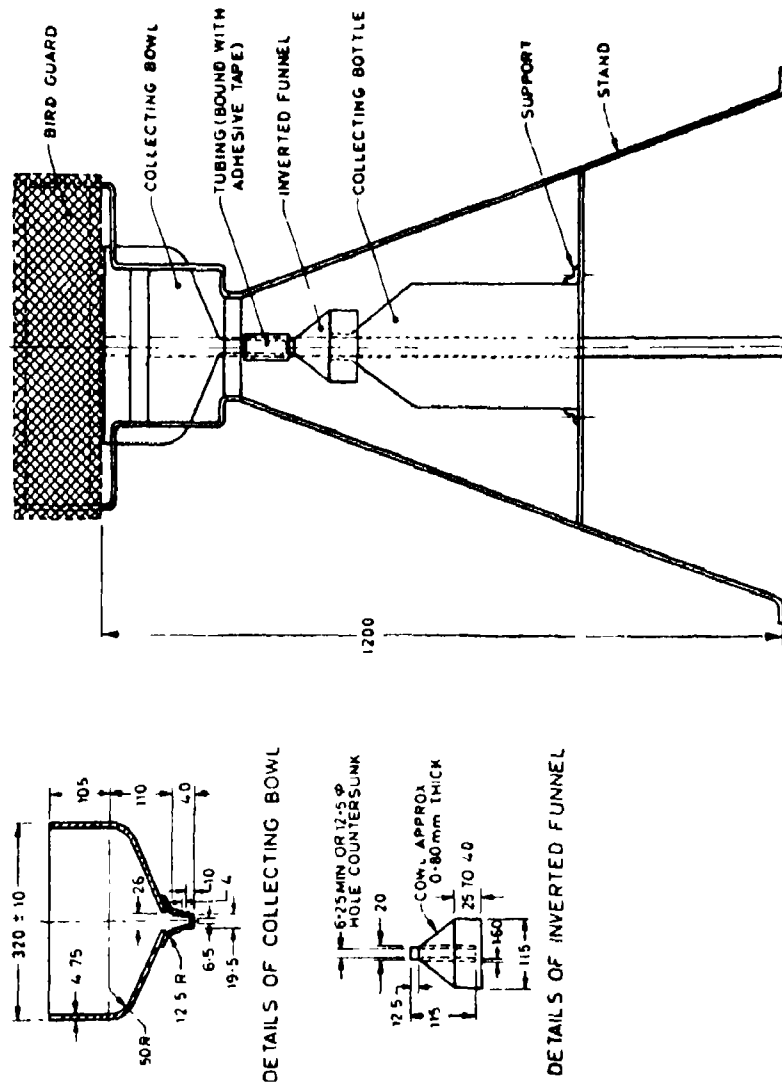
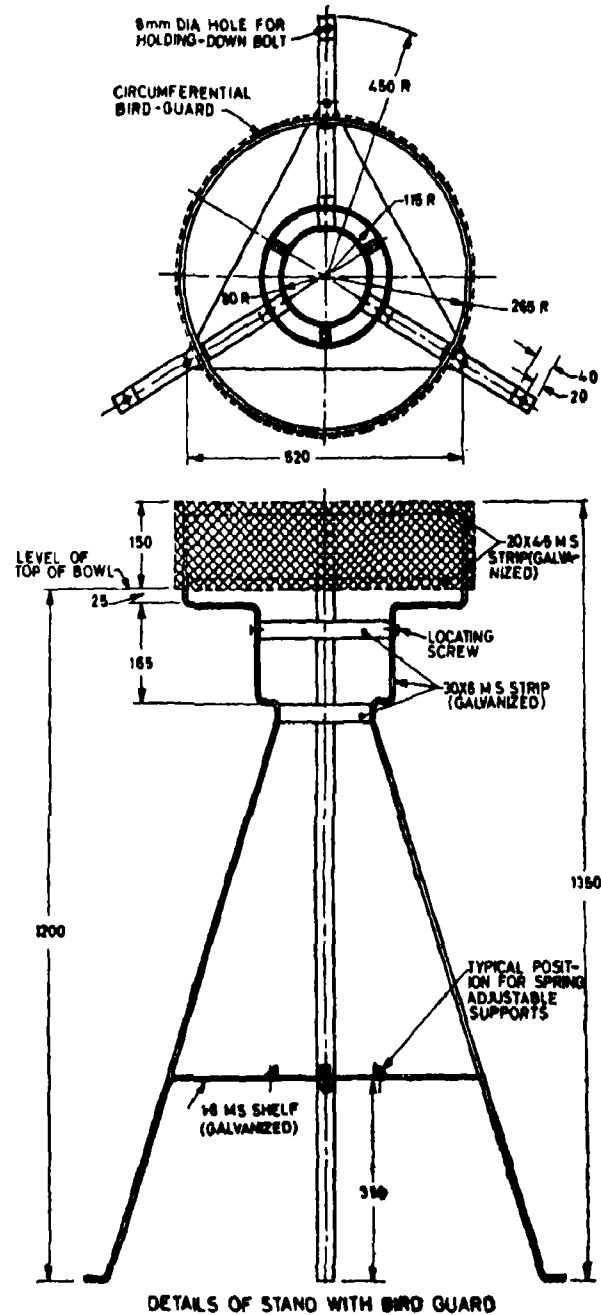


Fig. 8 PENT ROOF SHED (FOR HOUSING WET CANDLE)



DETAILS OF DEPOSIT GAUGE ASSEMBLY
FIG. 9 APPARATUS FOR MEASUREMENT OF AIR POLLUTION, SOLID MATERIALS — *Contd*

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DETAILS OF STAND WITH BIRD GUARD

All dimensions in millimetres.

FIG. 9 APPARATUS FOR MEASUREMENT OF AIR POLLUTION,
SOLID MATERIALS

AMENDMENT NO. 1 MARCH 1989
TO
IS : 5555 - 1970 CODE OF PROCEDURE FOR
CONDUCTING FIELD STUDIES ON
ATMOSPHERIC CORROSION OF METALS

(*Page 7, clause 6.1*) — Substitute the following for the existing clause:

'6.1 Identification marks shall not be stamped on the specimens as they are likely to be obliterated by corrosion. Instead holes can be made at any one of the nine places lengthwise in each of the three rows. First row indicates the units 1 to 9, second row indicates 10 to 90 and third row indicates 100 to 900. As an example Fig. 2 shows specimens No. 59. It has a hole at the fifth place in tens (second row) and a hole at the ninth place in units (first row). The specimen number can be identified with the help of master panel sheet.'

(*Page 7, Fig. 2*) — Substitute the figure on page 2 for the existing figure: